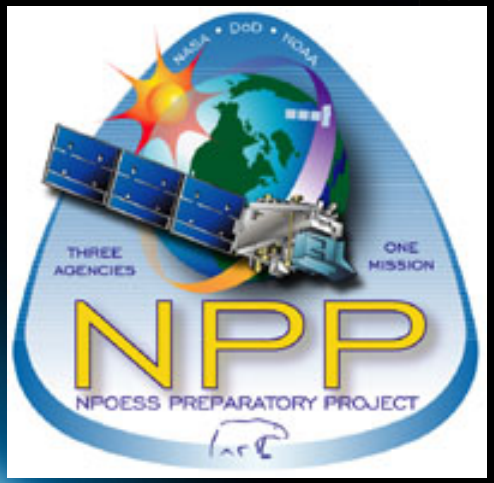
NPP (*National Polar-Orbiting Operational Environment Satellite System Preparatory Mission*)



NPP Objectives

The NPP mission has two major objectives:

- To provide continuation of the group of Earth system observations initiated by the Earth Observing System (EOS) Terra, Aqua, and Aura missions
- To provide the operational forecasting community with pre-operational risk reduction, demonstration, and validation for selected NPOESS (now JPSS) instruments and ground processing data systems.

→ Together these measurements and data records will fulfill U.S. Global Change Research Program (USGCRP) objectives of building a knowledge base that informs human responses to climate and global change.

NPP: Time Series Data to Reveal Global Change

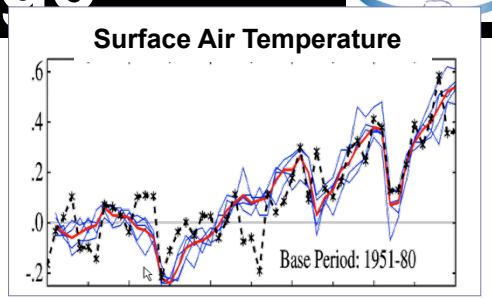
Satellites: POES ➔ EOS ➔ NPP ➔ JPSS*

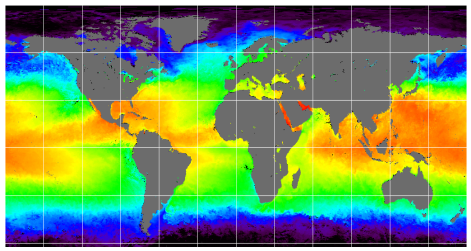
How is the global Earth system changing?

- atmospheric temperature and moisture profiles
- variability in ocean color and temperature
- vegetation productivity patterns

How does the Earth System respond to natural and human-induced changes?

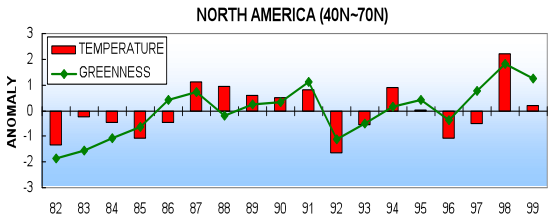
- vegetation responses to climate
- ozone layer recovery
- clouds and aerosols

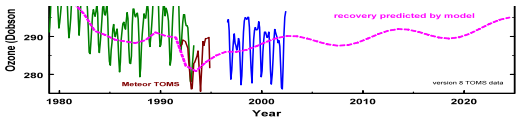




Atmospheric Sounding

Multispectral Imaging / Surface Biophysical Properties





Total Ozone Monitoring

*JPSS: Joint Polar Satellite System (formerly NPOESS)

NPP Instruments

Five sensors will be flown on the NPP mission:

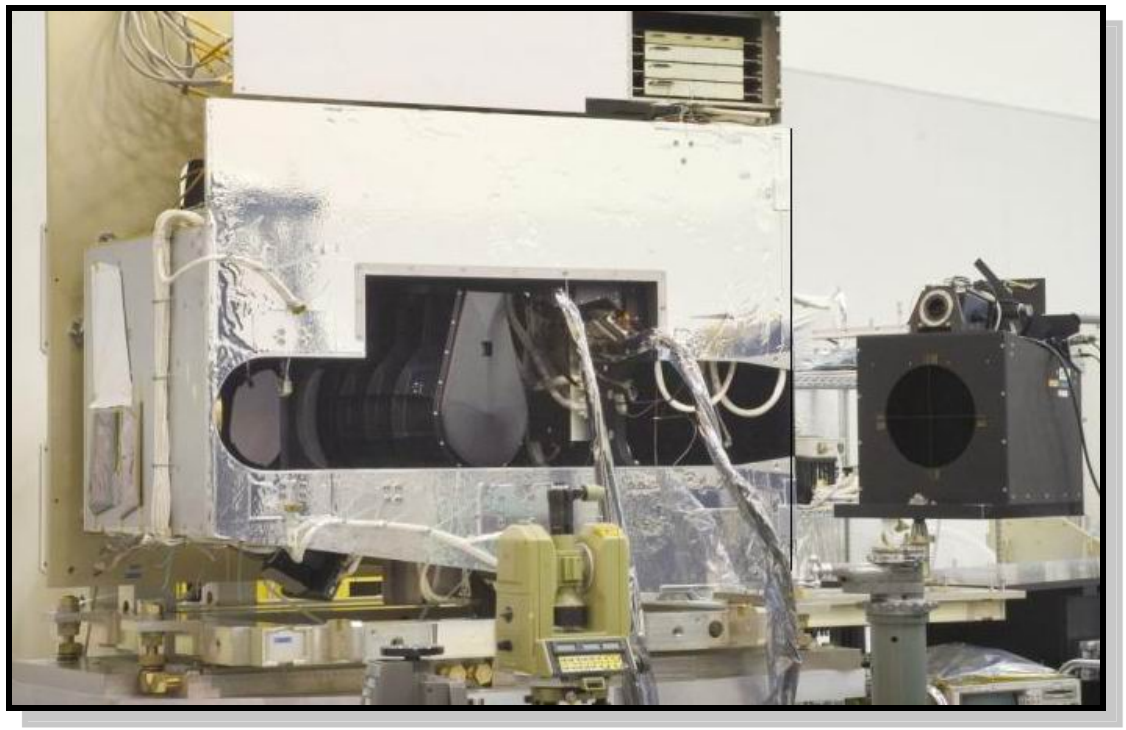
- **Visible Infrared Imaging Radiometer Suite (VIIRS)**
- **Cross-track Infrared Sounder (CrIS)***
- **Advanced Technology Microwave Sounder (ATMS)***
- **Ozone Mapping and Profiler Suite (OMPS), and**
- **Clouds and the Earth's Radiant Energy System (CERES)**

** CrIS and ATMS together are referred to as Cross-track Infrared Microwave Sounding Suite (CrIMSS)*

Visible Infrared Imaging Radiometer Suite (VIIRS)

Description

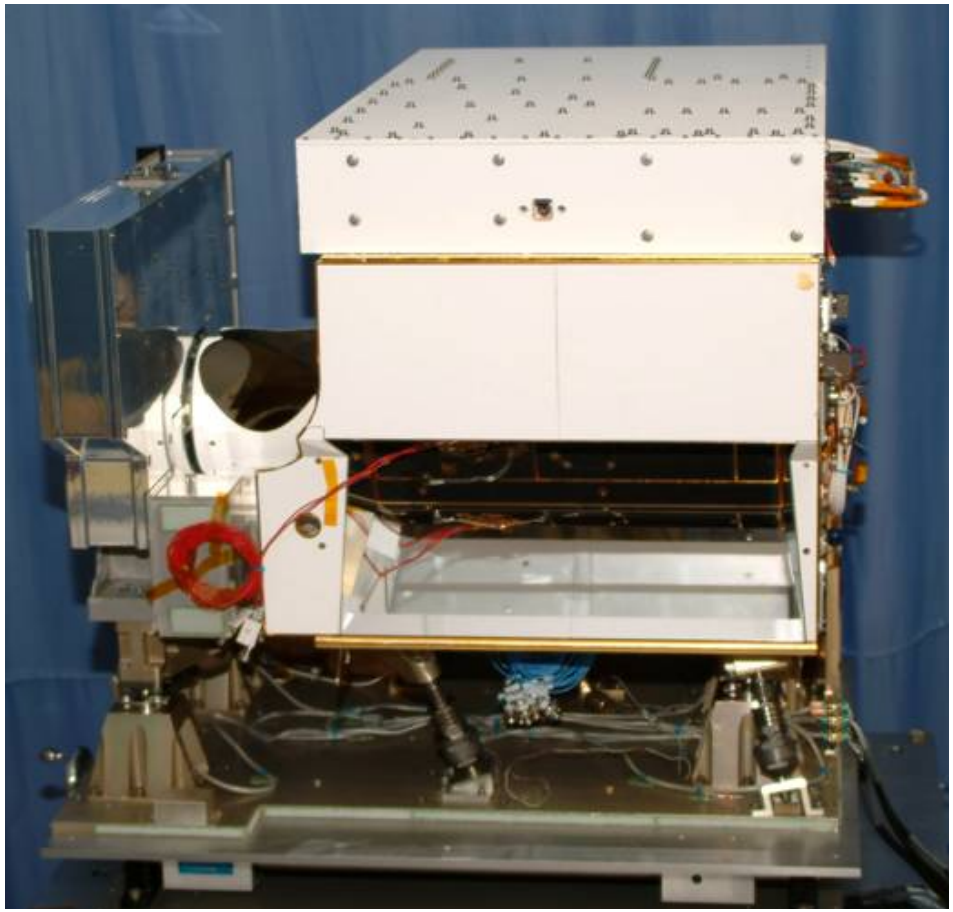
- **Purpose:** Global observations of land, ocean, & atmosphere properties at high temporal resolution (~ daily)
- **Predecessor Instruments:** AVHRR, OLS, MODIS, SeaWiFS
- **Approach:** Multi-spectral scanning radiometer (22 bands between 0.4 µm and 12 µm) 12-bit quantization
- **Swath width:** 3000 km



Cross-Track Infrared Sounder (CrIS)

Description

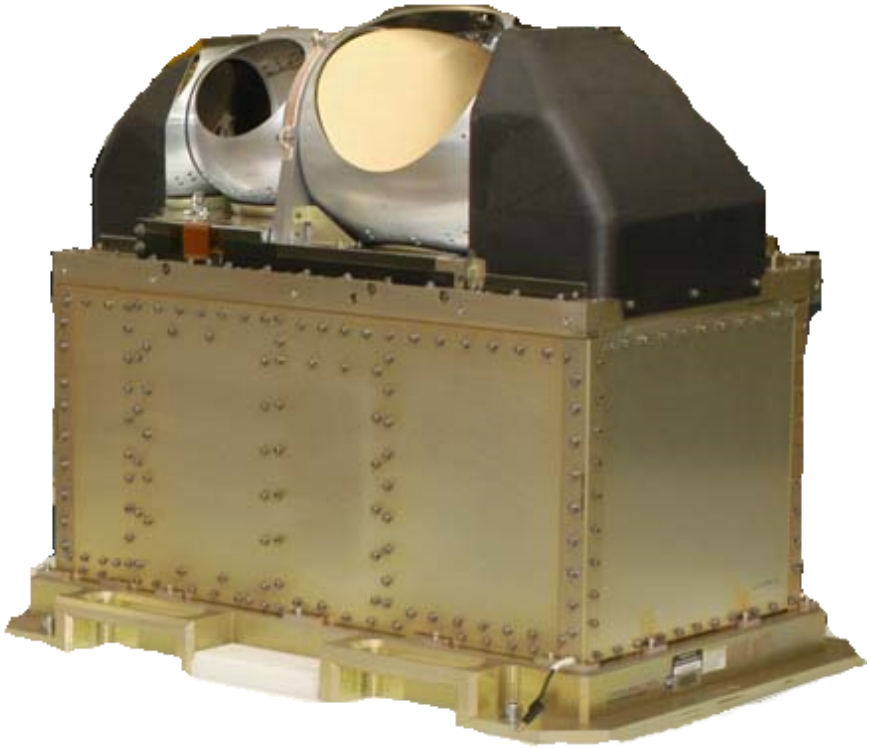
- **Purpose:** In conjunction with ATMS, global observations of temperature and moisture profiles at high temporal resolution (~daily)
- **Predecessor Instruments:** HIRS, AIRS, IASI
- **Approach:** Michelson Interferometer (1142 channels in 3 bands (3.5 µm - 16 µm))
- **Swath width:** 2300 km
- **Co-registration:** with ATMS



Advanced Technology Microwave Sounder (ATMS)

Description

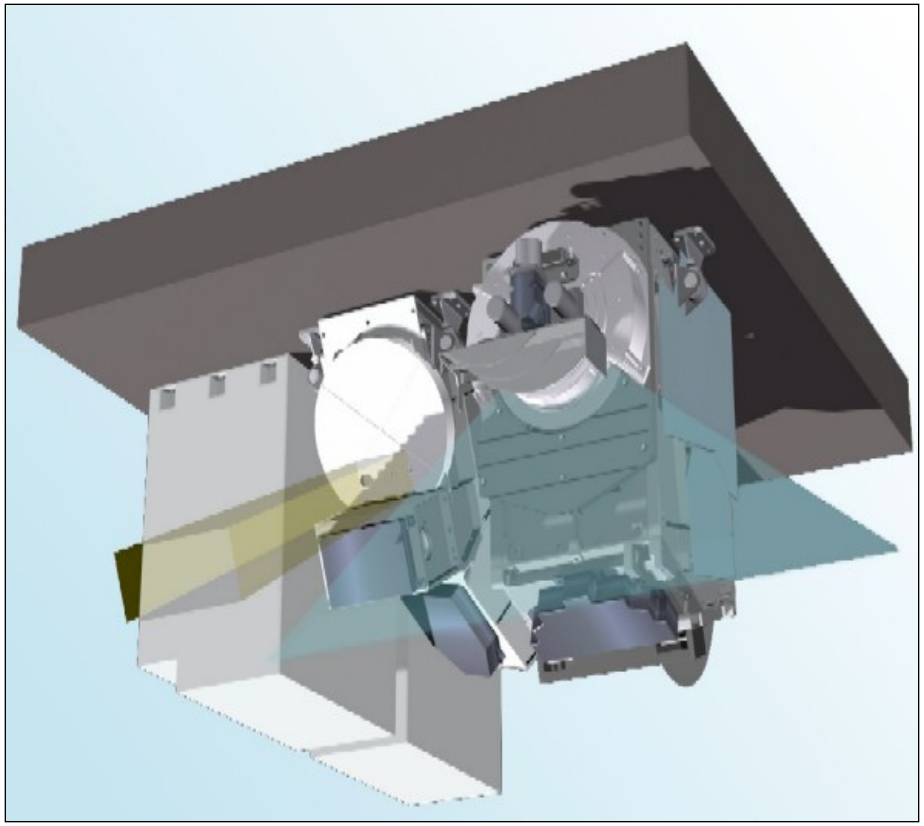
- **Purpose:** In conjunction with CrIS, global observations of temperature and moisture profiles at high temporal resolution (~ daily).
- **Predecessor Instruments:** AMSU A1 / A2, AMSU-B, MHS
- **Approach:** Scanning passive microwave radiometer (22 channels (23GHz - 183GHz)
- **Swath width:** 2300 km
- **Co-registration:** with CrIS



Ozone Mapping Profiler Suite (OMPS)

Description

- **Purpose:** Monitors the total column and vertical profile of ozone
- **Predecessor Instruments:** TOMS, SBUV, GOME, OSIRIS, SCIAMACHY
- **Approach:** Nadir and limb push broom CCD spectrometers
- **Swath width:** 2600 km



Limb status: 50/50 cost share NOAA and NASA
NASA to develop algorithm
NOAA to support operational users

Clouds and the Earth's Radiant Energy System (CERES)

- **CERES scanning radiometer measuring three spectral bands at TOA**
  - Total (0.3 to >50 μm)
  - Shortwave (0.3 to 5.0 μm)
  - Longwave Bandpass (8 to 12 μm)
- **Operations, Data Processing, Products, and Science are a continuation of experience developed on**
  - TRMM (1), EOS Terra (2), EOS Aqua (2)
- **Current Status: On NPP**

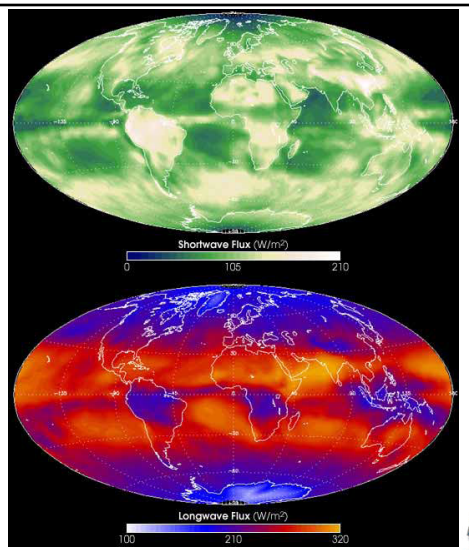
Margins

CERES	Spec	CBE
Mass - kg	50	50
Power (Avg.) - W	50	50
Power (Max) - W	75	75
Data Rate (Avg.) - Kbps	10	10
Data Rate (Max) - Kbps	10	10

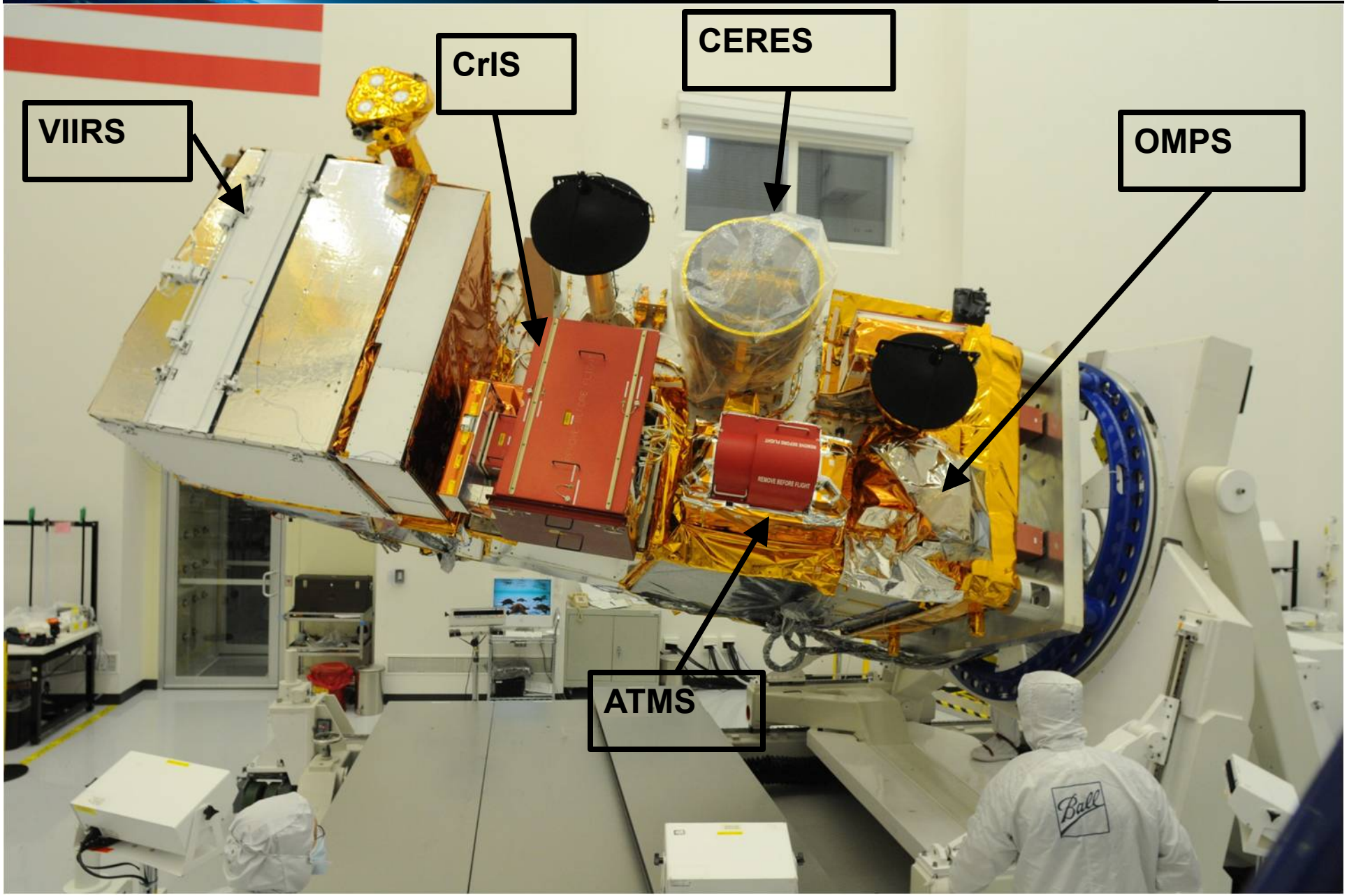
Primary CERES Climate Data Records

Reflected Solar Energy

Emitted Thermal Energy



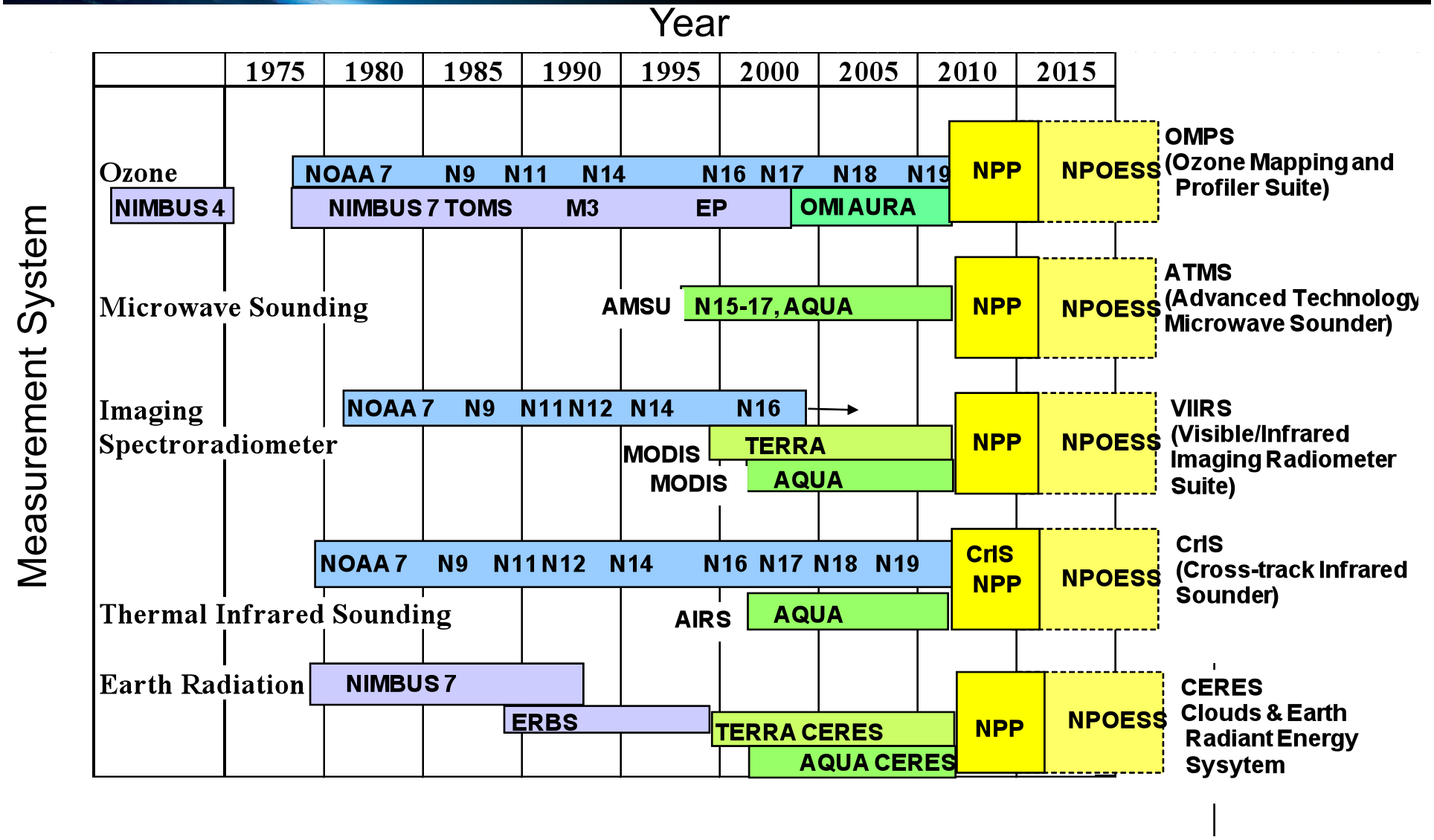
NPP Spacecraft with 5 Instrument



NPP Mission / Sensor Facts

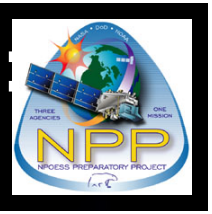
Orbit: NPP will be in a sun-synchronous, circular, polar orbit with a 1:30 pm crossing time at an altitude of 824 km.
Temporal Coverage: 16-day repeat cycle (8-day quasi-repeat) that is similar to the orbits of the Terra and Aqua satellites.
Instruments:
Spatial Resolution: Varies with sensor **(VIIRS -** 16 bands at 750 m; 5 at 325 m)
Coverage: Global; swath width is 3,000 km
Temporal coverage: near daily
Standard Data Products : Environmental Data Records (EDRs), +???
Data Latency: Near real time for EDRs
Launch Date: 2011
Mission Duration: 5 years
Website: http://jointmission.gsfc.nasa.gov/

NPP Continues Data Time Series



Conventional Operations EOS Technology Jump Research Quality Operations

NPP is a Little Different from Other Missions: NPP, NPOESS, and JPSS . . .



- NPP and NPOESS (now JPSS) have a long, complicated history
- The tri-agency NPOESS partnership (DOD, NOAA, NASA) is in the final stages of being dissolved
  - "NPOESS" is no more
  - The NOAA-NASA partnership continues under the Joint Polar Satellite System (JPSS) – afternoon platform series
  - DOD is continuing alone -- early morning platform series
- Agency roles and responsibilities are changing/evolving under JPSS
- NASA's NPP mission has not changed its name – it is still the NPOESS Preparatory Project.

NASA NPP Rationale

- **The NPOESS Preparatory Project (NPP) will provide a bridge to ensure data continuity between the NASA EOS research satellites and the JPSS (formerly NPOESS) operational environmental satellite system.**
  - **NPP is the first satellite mission to address the challenge of continuing a climate-quality time series of observations for a wide range of land, ocean, and atmospheric science data sets while simultaneously preparing to address operational requirements for meteorological observations.**
  - **The emphasis for NASA is on securing continuous, well-characterized, long time series measurements of sufficient quality to answer critical Earth system science, global change, and/or applied sciences questions.**

NPP Agency Roles

Agency roles and responsibilities for NPP are as follows:

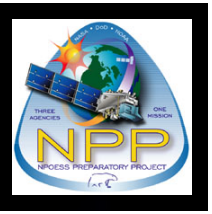
- **NASA provides the ATMS and CERES instruments, spacecraft, and launch services.**
- **JPSS (formerly NPOESS IPO) provides the CrIS, VIIRS, and OMPS nadir instruments; Command Control and Communications Segment (C3S); and the Interface Data Processing Segment (IDPS).**
- **NOAA provides the data Archive and Distribution Segment (ADS) and the OMPS limb capability**

NPP Data System and Products

NPP data will be processed by the JPSS (formerly NPOESS) data system. The Interface Data Processing Segment (IDPS) receives raw instrument data and telemetry from ground stations

- **The IDPS captures the Raw Data Records (RDRs) from the data stream, then processes the RDRs into Sensor Data Records (SDRs) and ultimately 24 Environmental Data Records (EDRs)**
- **During the time of NPP, the IDPS will supply RDRs, SDRs, and EDRs to two meteorological centers for evaluation or use in environmental applications and to the NOAA-provided Archive and Distribution Segment (ADS) for archiving and access/distribution to the broader user community.**
- **The IDPS also provides RDRs to NASA's Science Data Segment (SDS).**
- **As part of its Science Data Segment (SDS), NASA has developed several disciplinary Earth science Product Evaluation and Analysis Tool Elements (PEATEs) to support NPP Science Team members and the NPP Project staff in their evaluation of the EDRs**

NASA Product Evaluation and Analysis Tool Elements (PEATEs)



The NASA PEATEs provide support to the NPP Science Team to:

- **Analyze operational data records (RDR, SDR, or EDR)**
- **Analyze pre- and post-launch instrument calibration**
- **Analyze operational IDPS algorithm software**
- **Devise algorithm improvements, and**
- **Test and demonstrate calibration and algorithm improvements.**

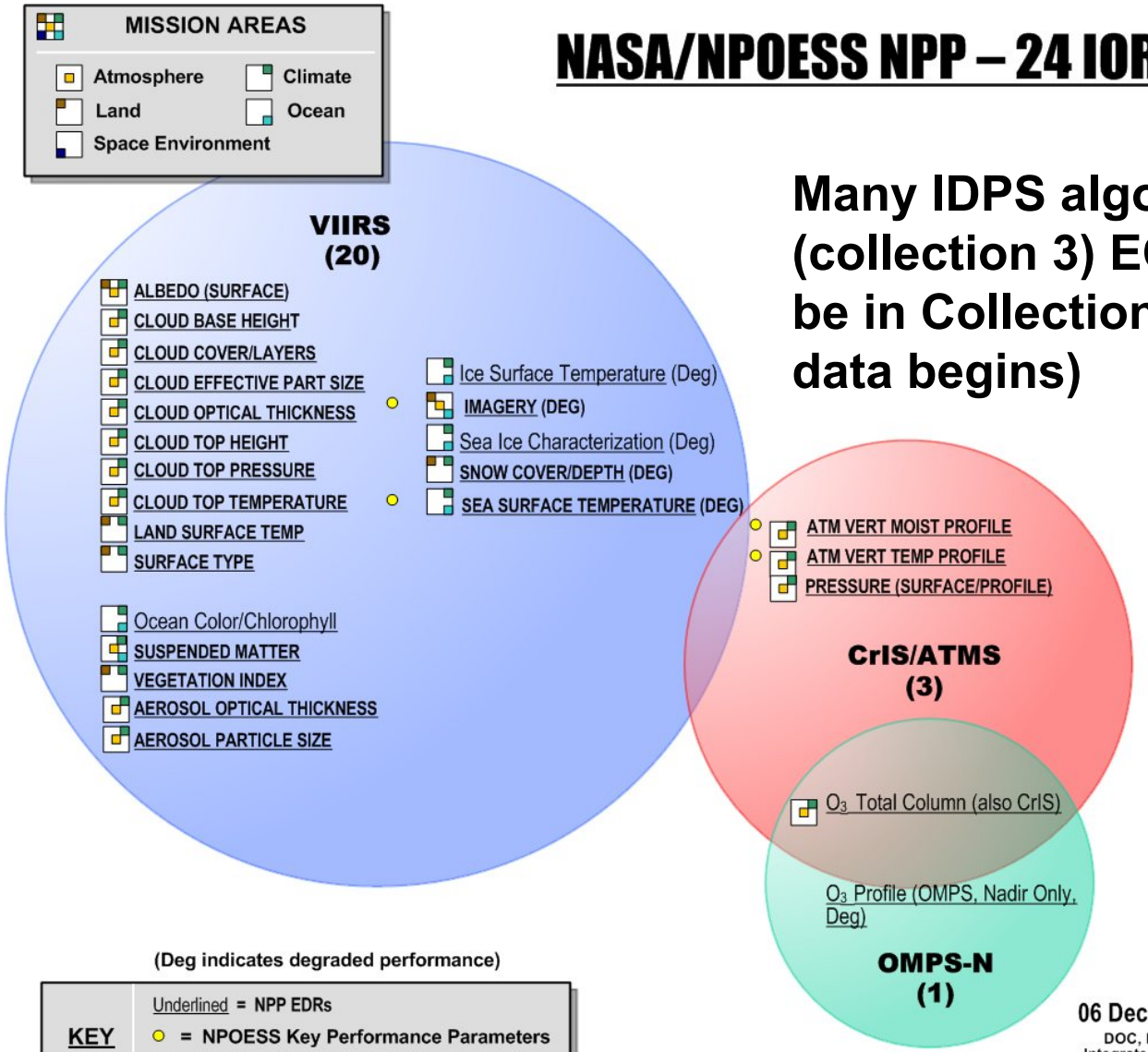
NPP Project Data -- Variations

However, data processing for OMPS and CERES follows a different plan

- **Only the nadir products from OMPS will be handled through the process described on prior charts.**
- **The limb-viewing solar occultation data from OMPS will be used to produce research products through the OMPS PEATE and will be archived separately by NASA.**
- **CERES data will be processed and data products produced at the Distributed Active Archive Center (DAAC) at NASA Langley Research Center where other CERES data products are produced.**

NPP/JPSS Data Products

NASA/NPOESS NPP – 24 IORD EDRs



(Deg indicates degraded performance)

KEY

Underlined = NPP EDRs

○ = NPOESS Key Performance Parameters

BOLD CAPS = LRD Environmental Data Records

Many IDPS algorithms have early (collection 3) EOS heritage. (EOS will be in Collection 6 by the time NPP data begins)

NASA Data Products:

- **CERES data products**
- **OMPS Limb ozone profile (future transfer to NOAA)**

06 December 2006

DOC, NOAA, NASA,
Integrated Program Office
M. Bonadonna, M. Haas,
D. Stockton, J. Whitcomb

NPP-V15

NPP Data Product for Climate Studie

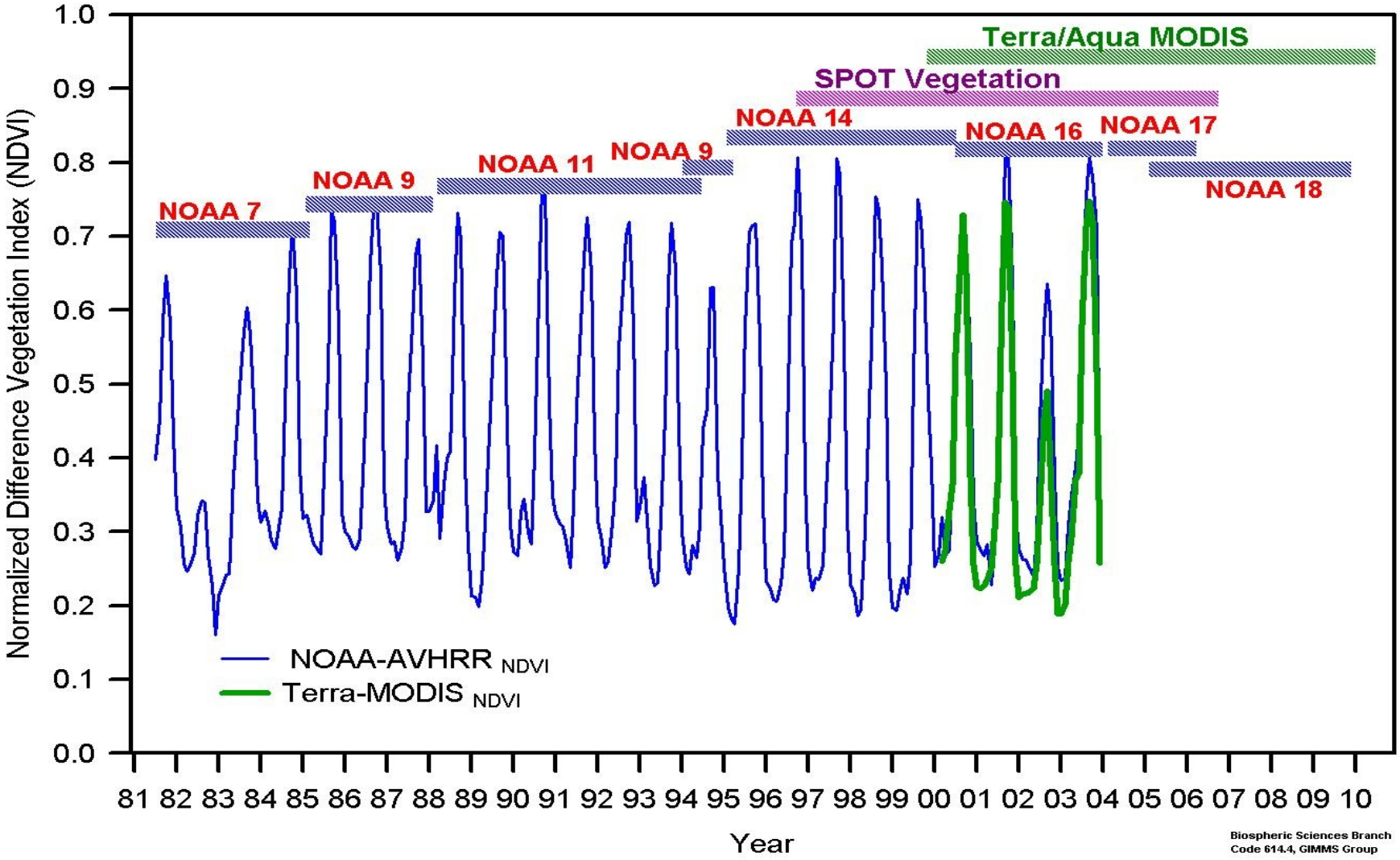
EDRs may not prove to be adequate for climate science

- no reprocessing planned currently
- some products won't be produced (e.g., surface reflectance)
- some products may not be of sufficient quality for climate science (current concerns about ocean color and aerosol products)

What then to do? At present, it is tbd. Options might include the following

- *Persuade JPSS (IDPS) or NOAA (ADS) to reprocess, improve their algorithms, and/or implement additional products*
- *Find another data system / center to fill the gaps*
- *Persuade NASA to undertake, perhaps leveraging existing PEATE and/or EOS DAAC capabilities*

Multi satellite NDVI time series

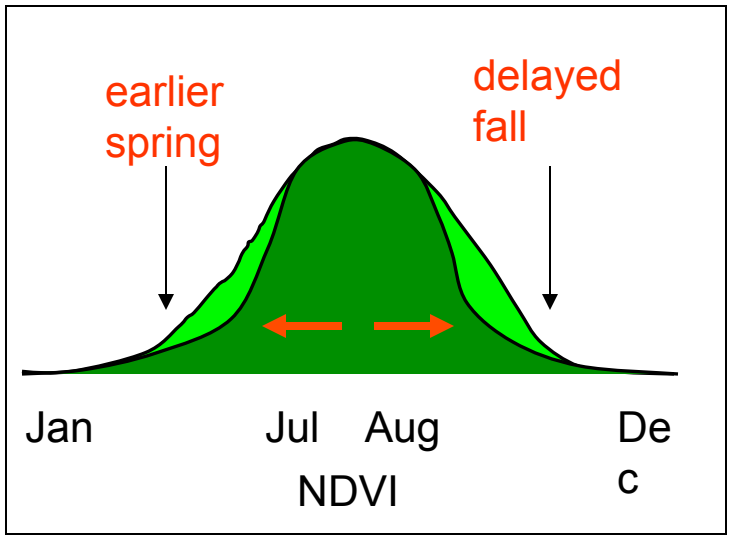


NDVI data set and the satellites that are used

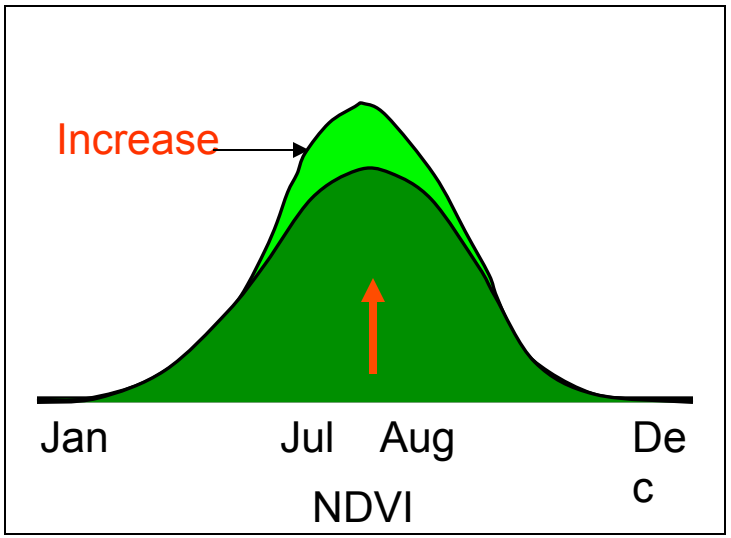
Changes in Vegetation Activity

- Changes in vegetation activity can be characterized through
  1. changes in growing season
  2. changes in seasonal NDVI magnitude

Increases in growing season

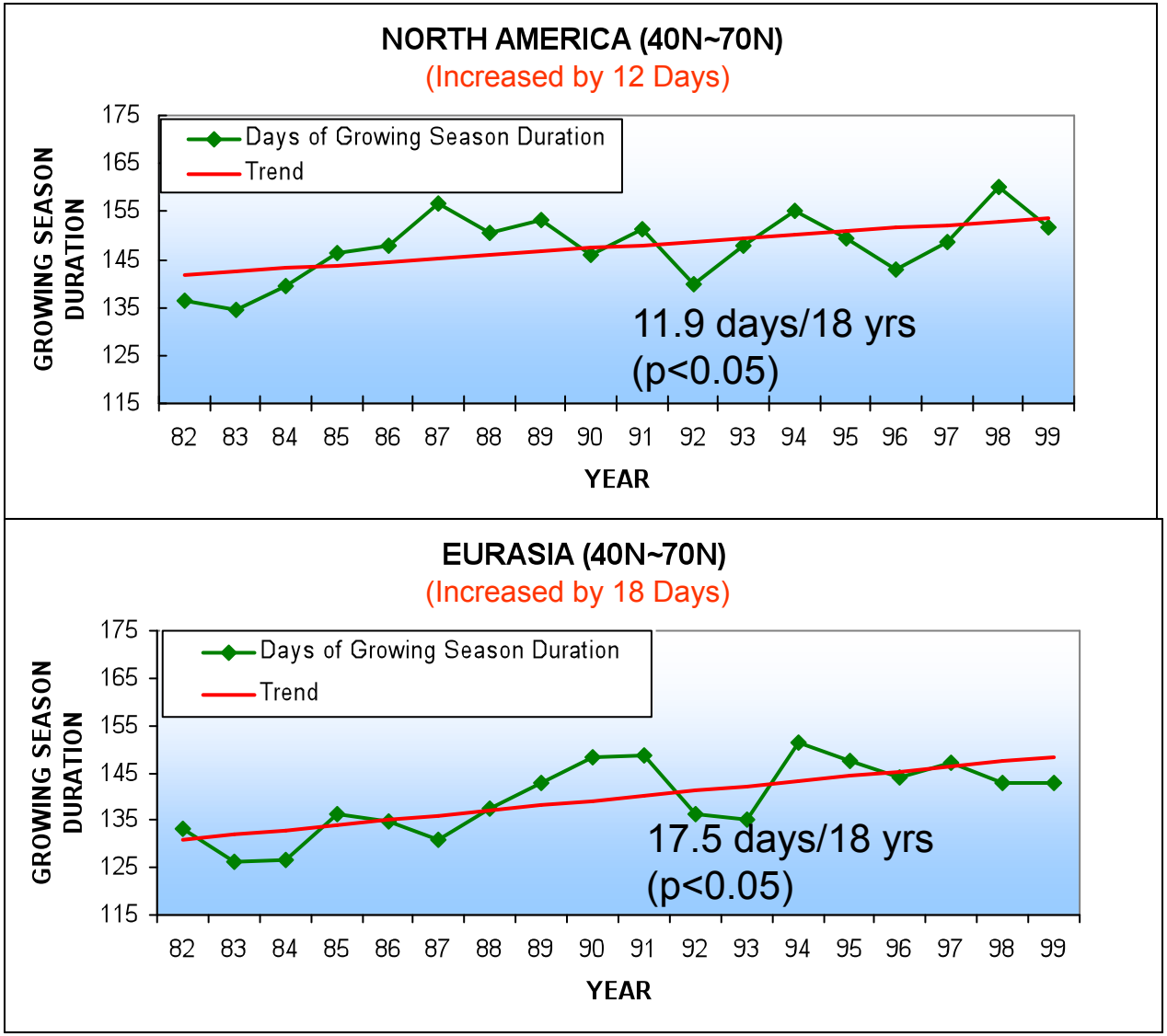


Increases in NDVI magnitude



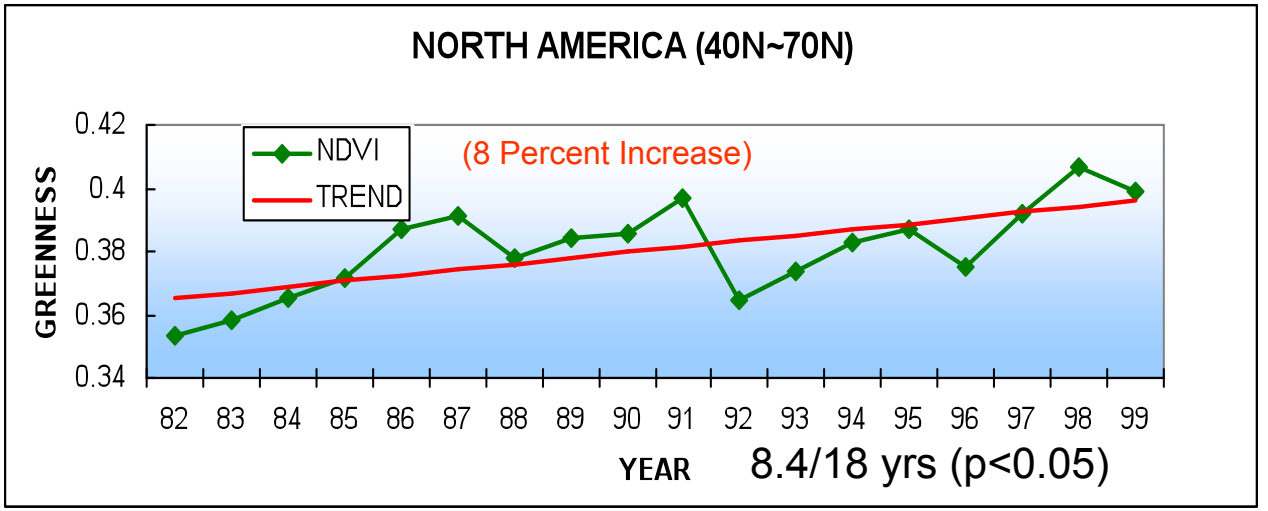
Zhou et al., 2001, J. Geophys. Res., 106(D17):20069-20083.

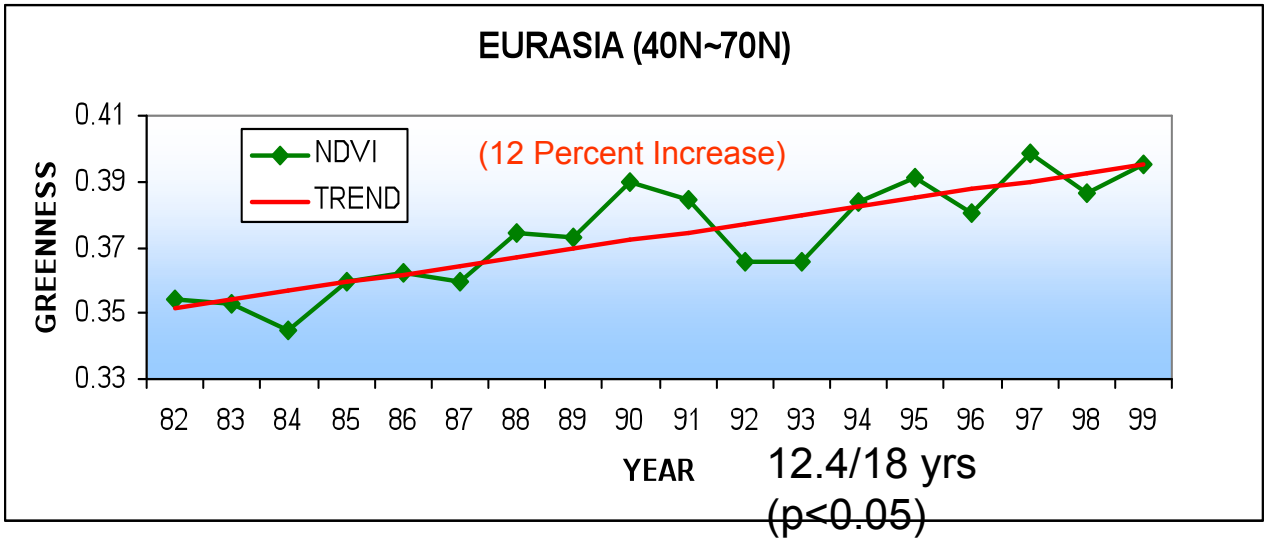
Longer Growing Season



Zhou et al., 2001, J. Geophys. Res., 106(D17):20069-20083.

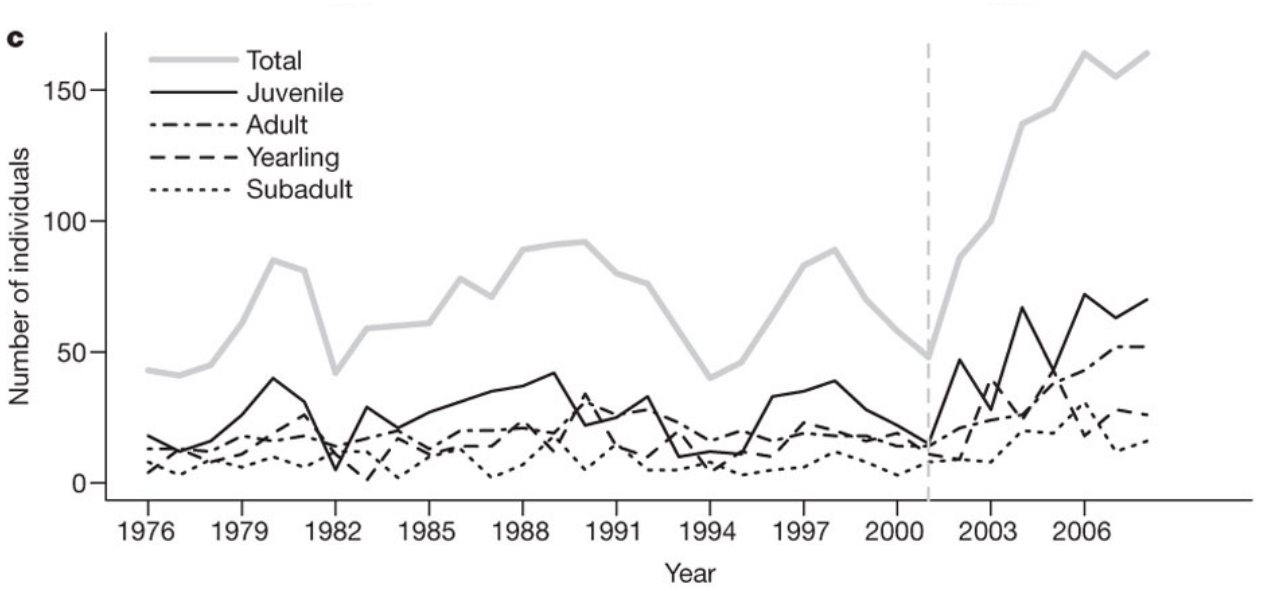
Increases in April-October NDVI Magnitudes





Zhou et al., 2001, J. Geophys. Res., 106(D17):20069-20083.

Longer Earlier Growing Season results in More, Fatter Marmots in Colorado



Coupled dynamics of body mass and population growth in response to environmental change

A Ozgul *et al. Nature* 466, 482-485 (2010) doi:10.1038/nature09210

nature

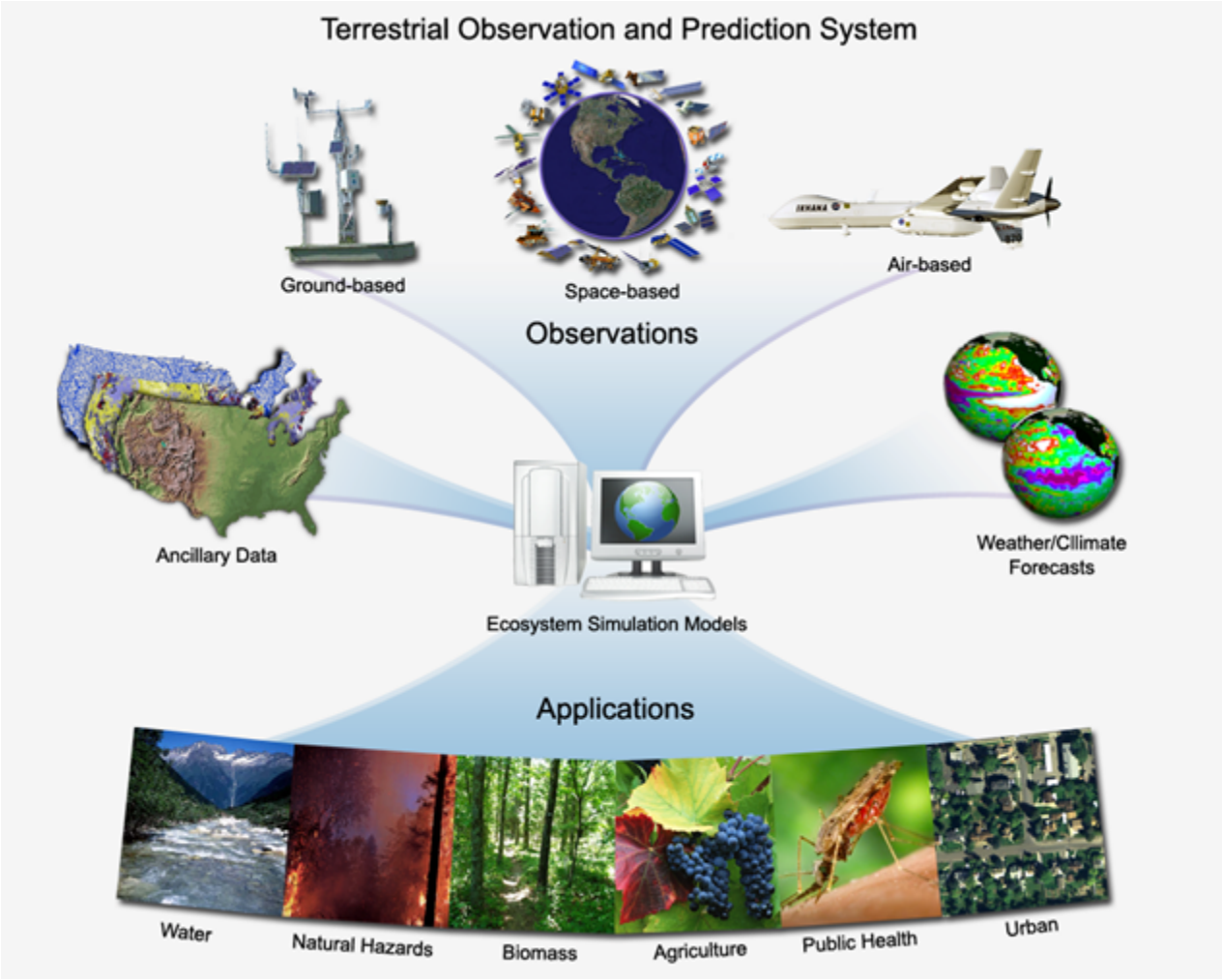
Terrestrial Observation and Prediction System (TOPS)

MODIS PRODUCTS (8 days/Annual)
1 LAI
2 FPAR
3 GPP/NPP*
4 LST-TERRA/AQUA
5 NDVI
6 EVI
7 LANDCOVER/Cont Fields*
8 ALBEDO
9 SNOW
10 FIRE

METEOROLOGY (Daily)
11 MAX TEMPERATURE
12 MIN TEMPERATURE
13 RAINFALL
14 SOLAR RADIATION
15 DEW POINT/VPD
16 DEGREE DAYS

TOPS-NOWCASTS (daily)
17 TOPS-SNOW
18 TOPS-SOIL MOISTURE
19 TOPS-ET
20 TOPS-OUTFLOW
21 TOPS-GPP/NPP
22 TOPS-PHENOLOGY
23 TOPS-VEG STRESS

TOPS-FORECASTS (5 days to 180 days)
24 BGC-LAI/PHENOLOGY
25 BGC-SOIL MOISTURE
26 BGC-OUTFLOW
27 BGC-ET
28 BGC-VEG STRESS
29 BGC-SNOW
30 BGC-GPP/NPP



Monitoring, Modeling, & Forecasting at Multiple Scales with Trend Analyses

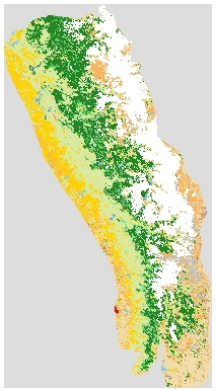
Nemani et al., 2003 and 2007; TOPS Slides from CSUMB/F. Melton

TOPS Products for Sierra Greater Park Ecosystems

Satellite

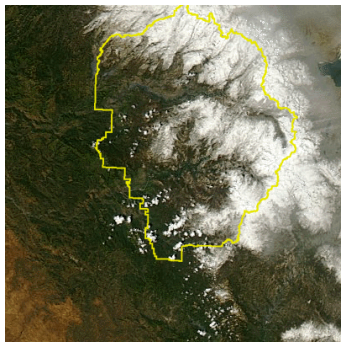
Vegetation indices

Snow Cover



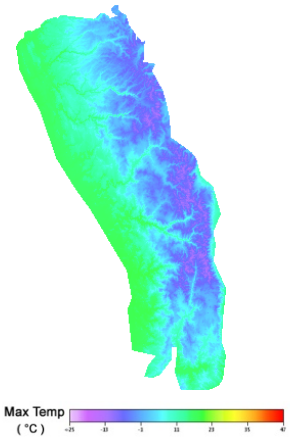
Leaf Area Index

MODIS Direct Broadcast

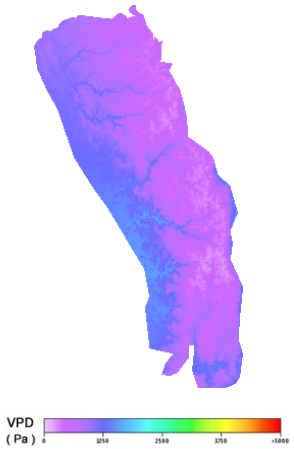


Climate

Maximum Temp.

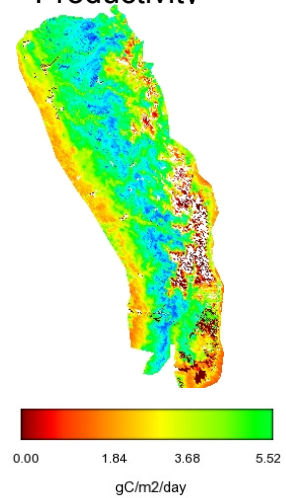


Vapor Pressure Def.



Ecosystem Model

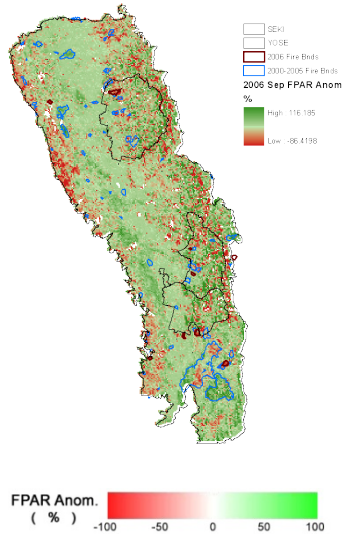
TOPS Gross Primary Productivity



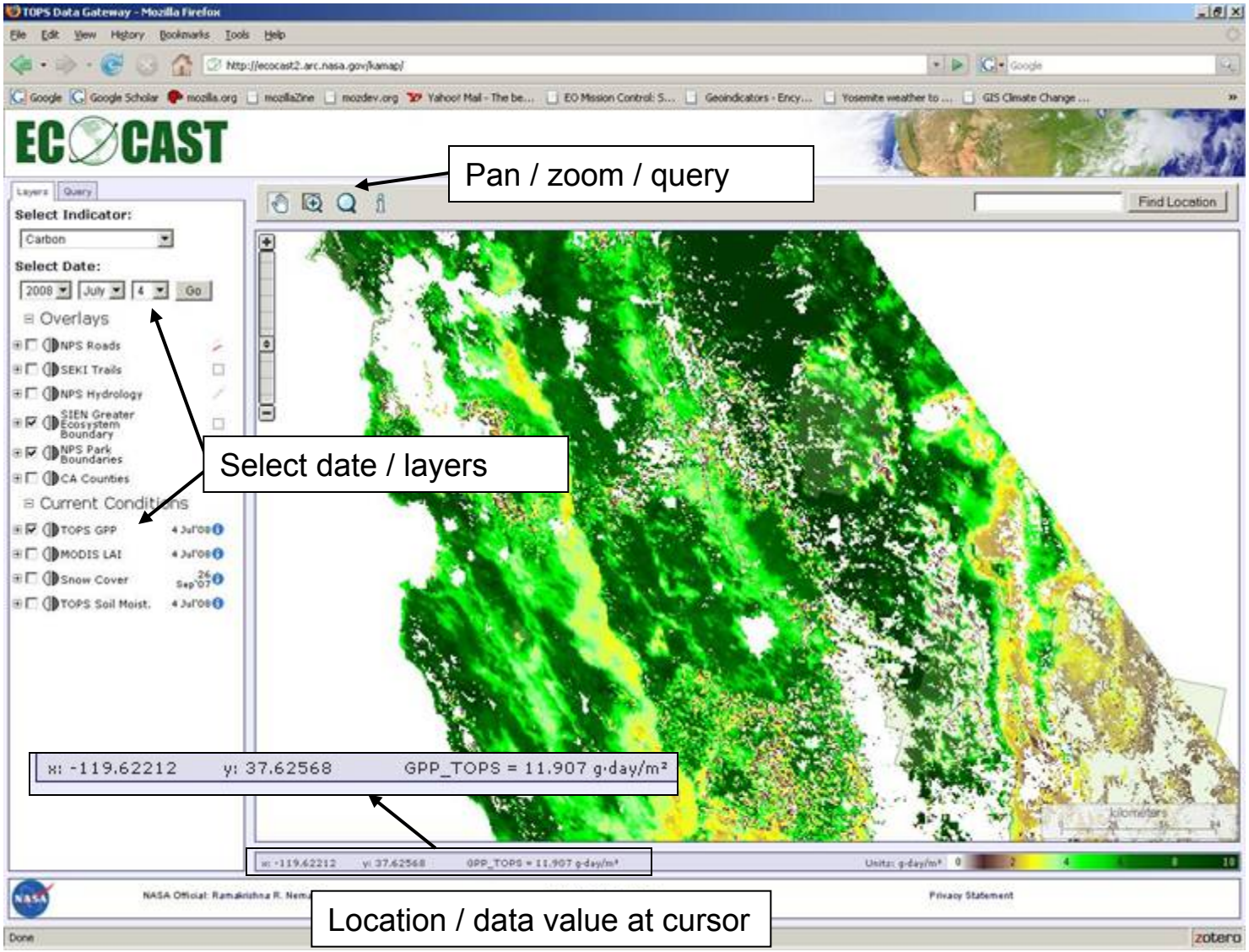
Soil Moisture

Trends & Anomalies

FPAR Anomaly

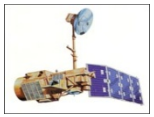


TOPS Data Gateway



- Browser-based data access and visualization system
- Rapid data access, visualization, query, and analysis
- Supports time series plots, data queries
- Direct access to metadata and standard operating procedures

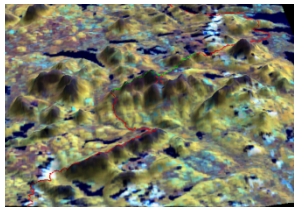
Appalachian National Scenic Trail MEGA-Transect Decision Support System

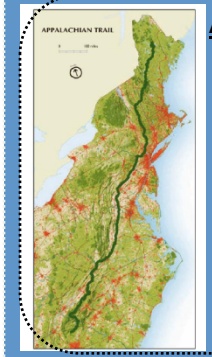


NASA ESS Data:
Observation from Space:
Landsat sensors
Terra/Aqua MODIS
ASTER
SRTM
Hyperion
LDCM (2011 …)

Managing A.T. from Land and Space

On-demand, predictive A.T.
and regional scale models and maps – Vital Signs
High-performance information system and modeling
Integrated access to biological field data and NASA Earth System Science Data with 3-D visualization through Internet





A.T. *in situ* observations:
Invasive Species
Pests/Pathogens
High Elevation Comm.
Rare, Threatened & Endangered Species
Landscape Dynamics
Air-Water Qualities
……

Database
Management
Archiving
Assessing
Disseminate
Sharing
Viewing
Mapping
……

→

NASA TOPS
Monitoring
Trend and Conditions
Simulation
Modeling
Forecasting
Early Warning
……

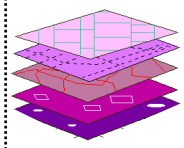
→

Decision Support And Decision Making

Provide a basis for understanding and identifying meaningful change in natural systems characterized by complexity, variability, and surprises
Determine trends of A.T. resources
Assess I&M efforts
Early warning of impending threats, undesirable conditions or trends
Enhance data management, reporting, and public education.
Public understanding through integrated analysis and modeling
Science-based sound decisions

NASA Data Products, Models, TOPS

High-speed data sharing via internet



LCLUC
NDVI/LAI
Soil moisture
Snow cover/depth
Gross/NPP
Evapotranspiration
Streamflow

Participating partners:
NASA, NPS, USGS, USDA, ATC, ATOP, Universities, citizen science volunteers, other agencies and NGOs

NASA · University of Rhode Island · National Park Service · USGS science for a changing world · USFS · Appalachian Trail Conservancy · MEGA-Transect Partners · National Geographic

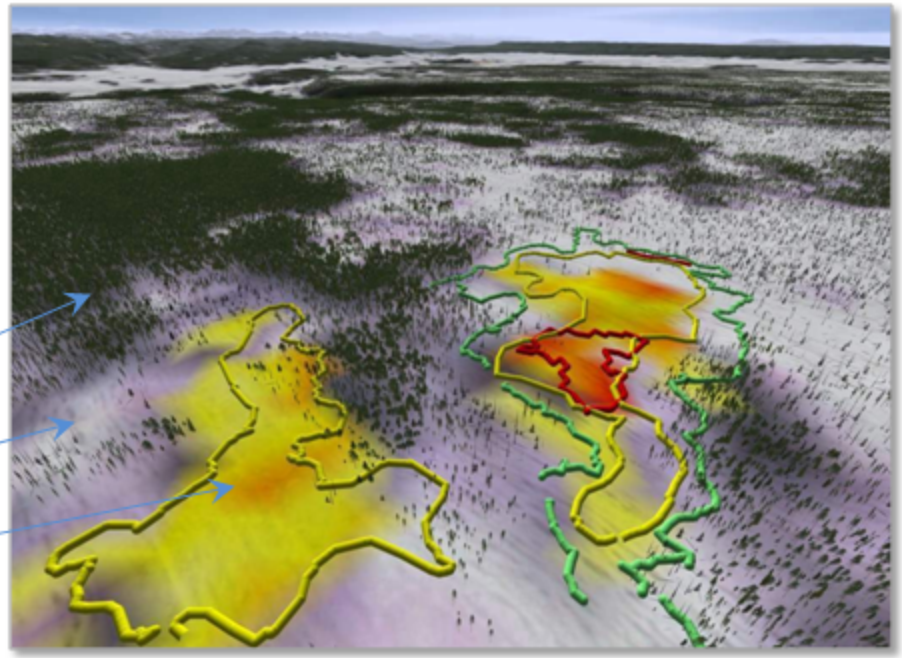
(URI/Y.Q. Wang)

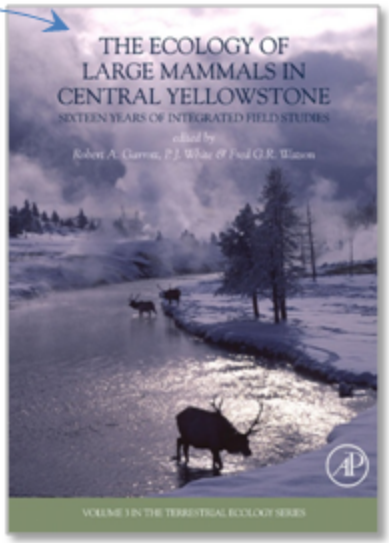
Systems Integration and Visualization of Yellowstone

Funding: NASA REASoN ~ NSF ~ NPS. **Investigators:** Fred Watson (CSUMB), Bob Garrott (MSU), PJ White (NPS), Susan Alexander (CSUMB)

System Characteristics:

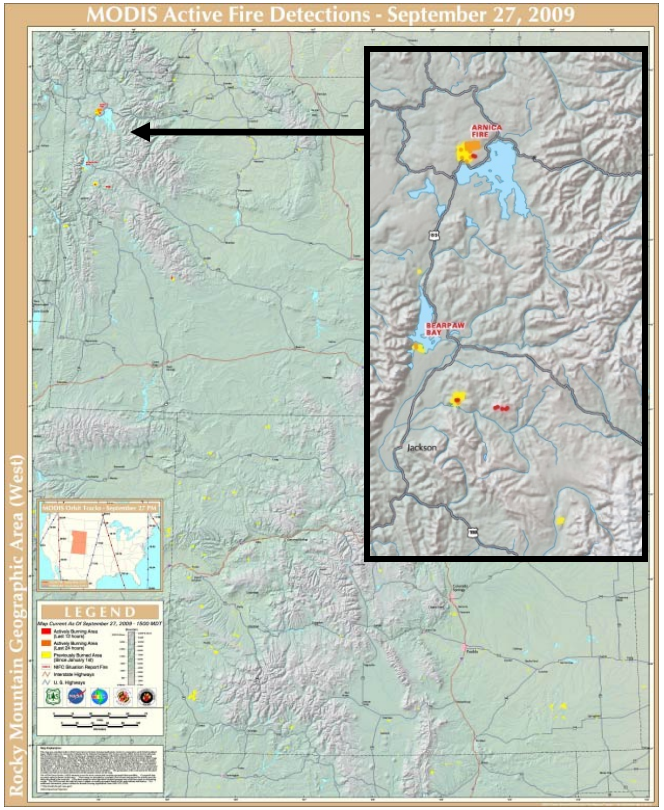
- Wildlife in Yellowstone National Park (Elk, Bison, Wolves)
- Managed by National Park Service
- Themes:
  - Movement of bison beyond Park boundary
  - Reduction in elk population due to wolf restoration
- Science:
  - Models of population and movement in response to climate variation, landscape dynamics, and other species
- NASA roles:
  - Characterize landscape dynamics:
    - Remote sensing of land cover
    - Snowpack simulation modeling
    - Remote sensing of geothermal heat intensity
    - Remote sensing of forage phenology
    - Wind field simulation modeling
  - Visualize system dynamics:
    - Fly-through videos deployed in NPS visitor centers and web sites
- Uses:
  - Research – Fundamental wildlife ecology
  - Application
    - Wildlife management policy: "Should roads be groomed in winter?"
    - Wildlife management operations "When should we expect bison to attempt cross-boundary migration?"
  - Education
    - "How do wildlife use the Yellowstone landscape?"
- Publications directly derived from this NASA funding:
  - 7 journal papers
  - 14 book chapters
  - 1 edited volume

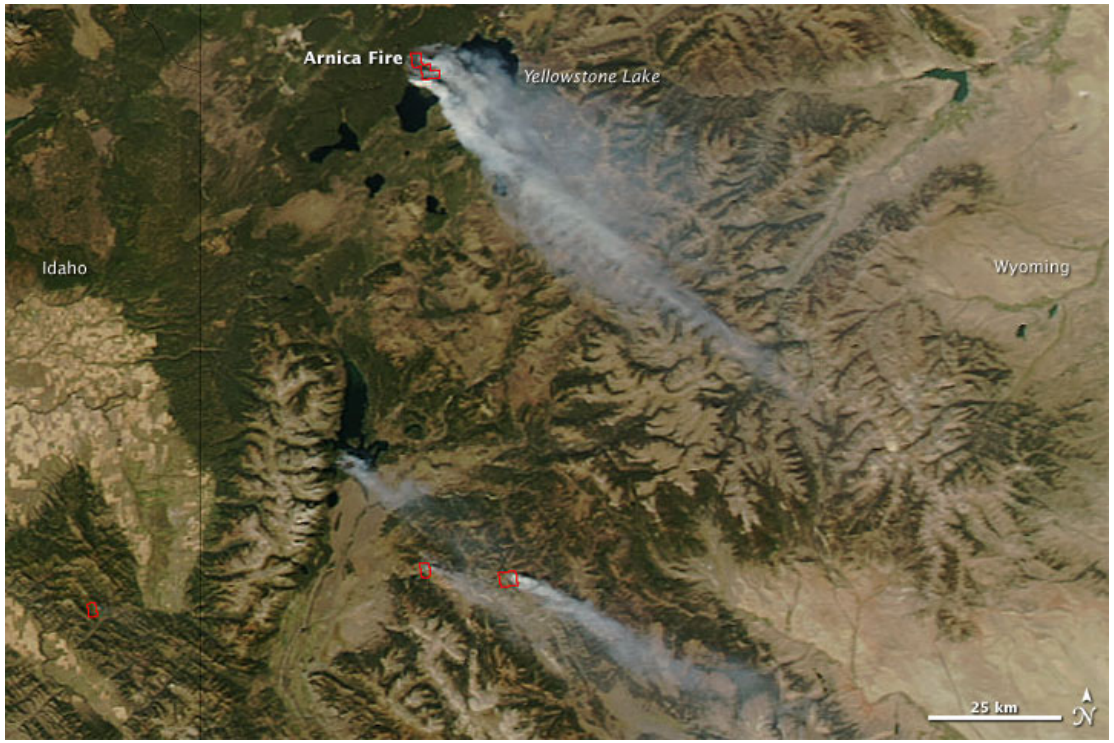




(slide from CSUMB/Fred Watson)

Forest Fire Management: USDA Forest Service MODIS Active Fire Mapping



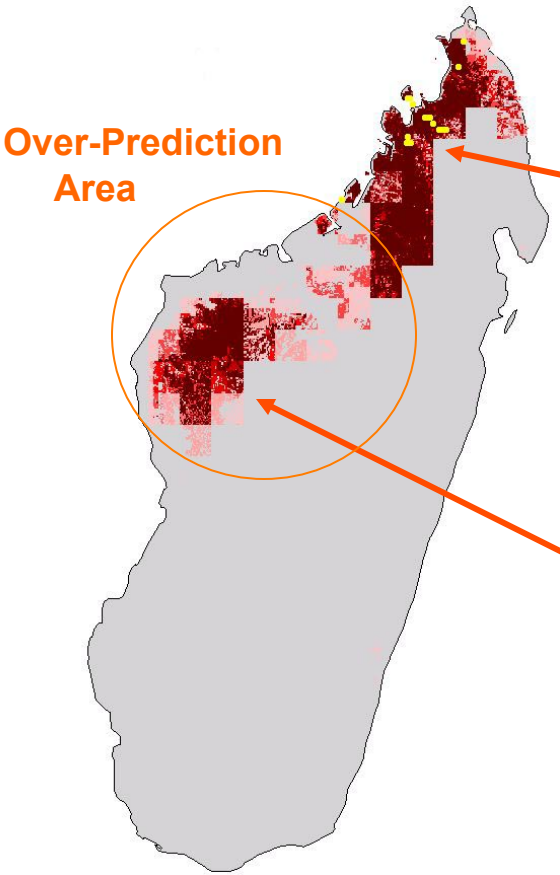


Yellowstone Fire September 27, 2009

The MODIS Active Fire Mapping Program provides a near real-time geospatial overview of the current wildland fire situation at regional and national scales. Locations of current fires and the extent of previous fire activity are ascertained using satellite imagery acquired by the MODIS sensor.. This information is utilized by fire managers to assess the current fire situation and serves as a decision support tool in strategic decisions regarding fire suppression resource allocation.

http://activefiremaps.fs.fed.us/index.php

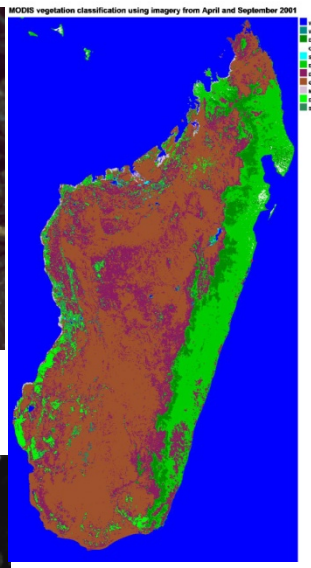
Predicting the Occurrence of Unknown Chameleon Sister Species



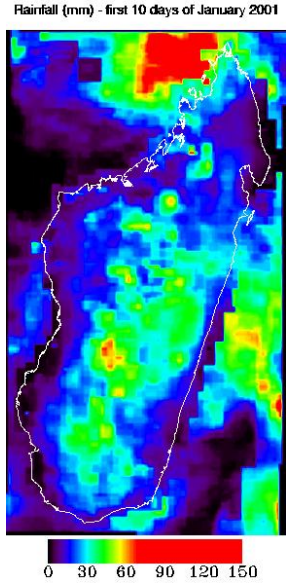
Modeled Distribution for *Brookesia stumpffi*

Brookesia stumpffi

Brookesia sp. nov.



MODIS Land Cover at 1km



NOAA Precipitation at 5 minutes resolution

Examples of Environmental Data Used

Satellite data were combined with species occurrence data in an ecological niche model (GARP) to predict occurrences of 11 chameleon species in Madagascar with success rates of 75 to 85 percent. Areas of over-prediction from the GARP model resulted in the discovery of 7 chameleon species new to science.

Raxworthy C.J. et al. Predicting distributions of known and unknown reptile species in Madagascar. Nature 426, 837-841 (2003).


Thank you!